Data Reorganization and Future Embedded HPC Middleware

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The Data Reorganization Forum

http://www.data-re.org

Join the mailing list discussion!

Goal: Final specification by June 2001

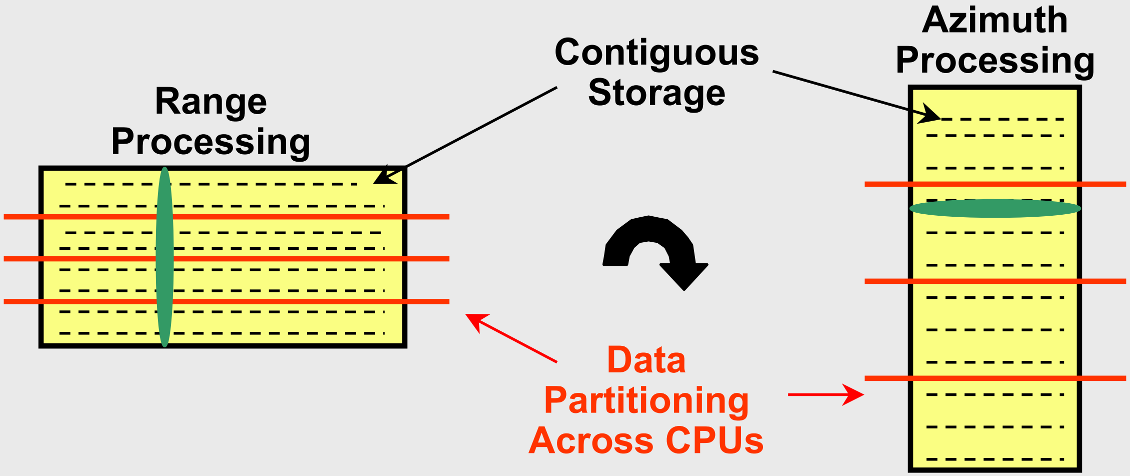
- Broad community participation includes:
  - FFRDCs and Government/Defense Laboratories
  - Defense integrators
  - Commercial embedded multicomputer vendors
  - Commercial HPC tool vendors
- Examining API’s, algorithms, and application requirements

What Problems Does Data Reorg Try To Solve?

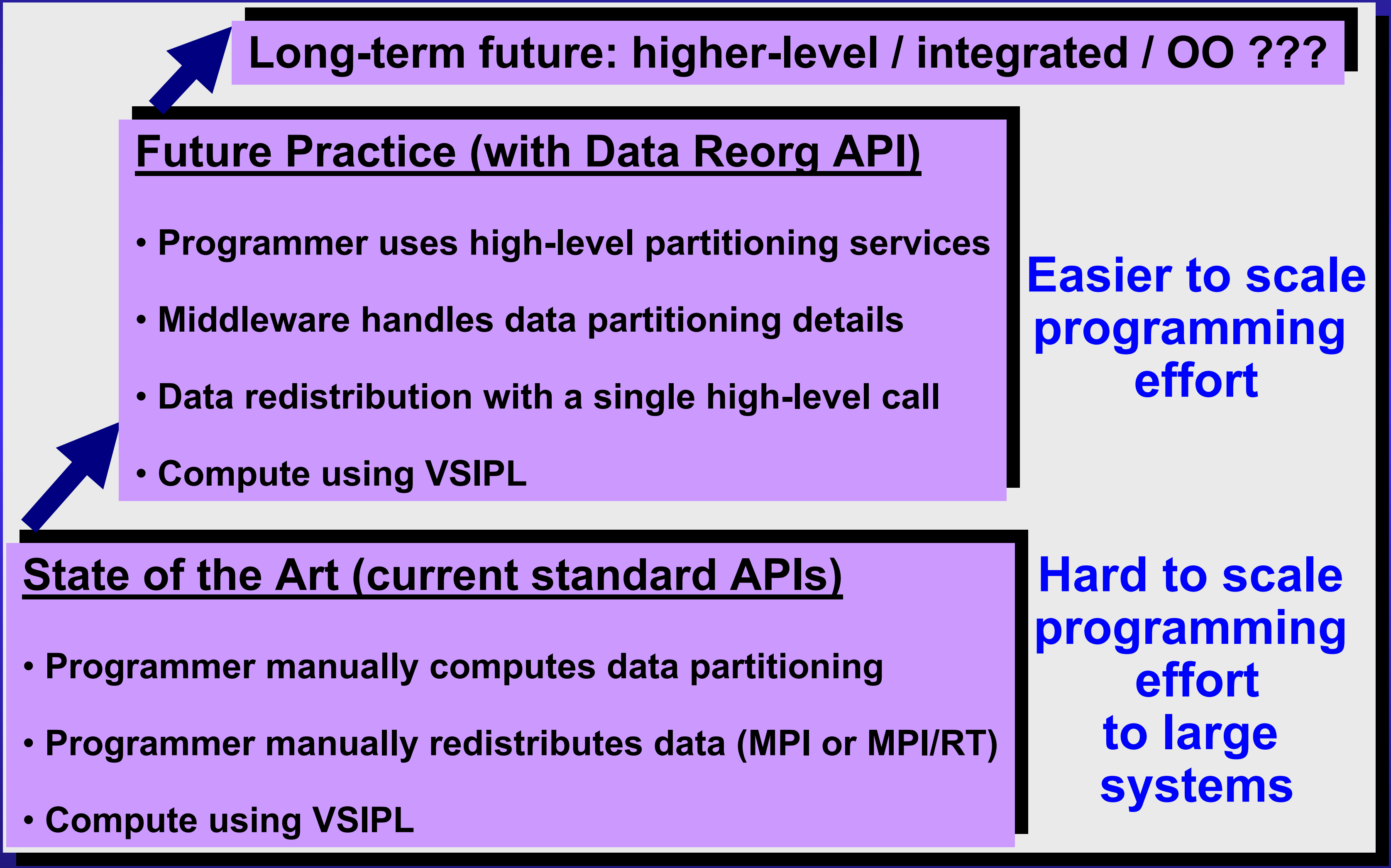
Data Partitioning and Redistribution Issues for Signal/Image Processing (SIP) Applications

- Block partitioning is most common
  - Whole problems stored in 1 memory for performance

- Data redistribution communication is “severe”
  - Prototypical example is matrix transpose in 2DFFT/SAR



Interface Scalability



Long-term future: higher-level / integrated / OO ???

Future Practice (with Data Reorg API)

- Programmer uses high-level partitioning services
- Middleware handles data partitioning details
- Data redistribution with a single high-level call
- Compute using VSIPL

Easier to scale programming effort

State of the Art (current standard APIs)

- Programmer manually computes data partitioning
- Programmer manually redistributes data (MPI or MPI/RT)
- Compute using VSIPL

Hard to scale programming effort to large systems

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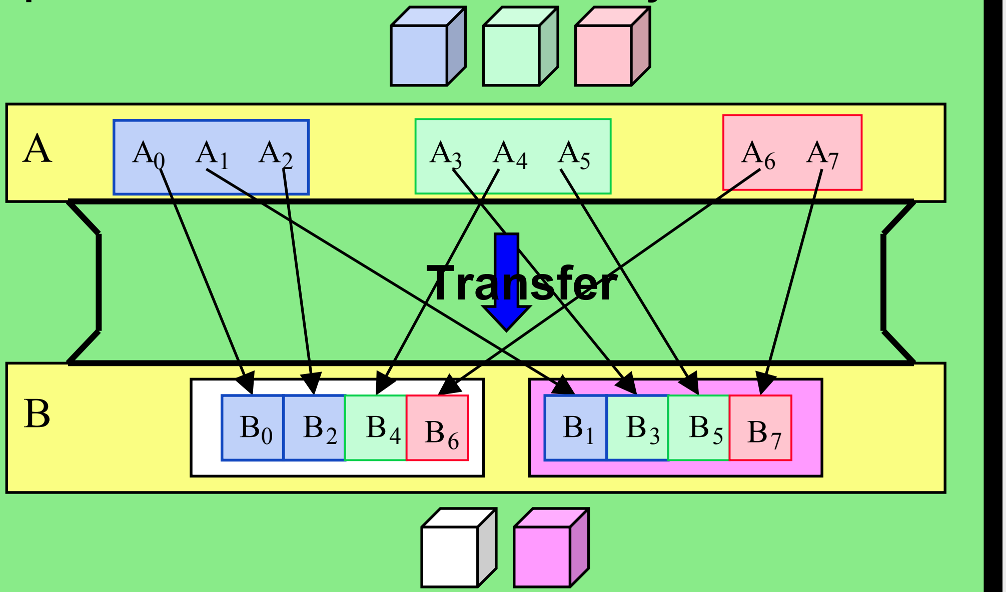
Data Reorg Interface Example

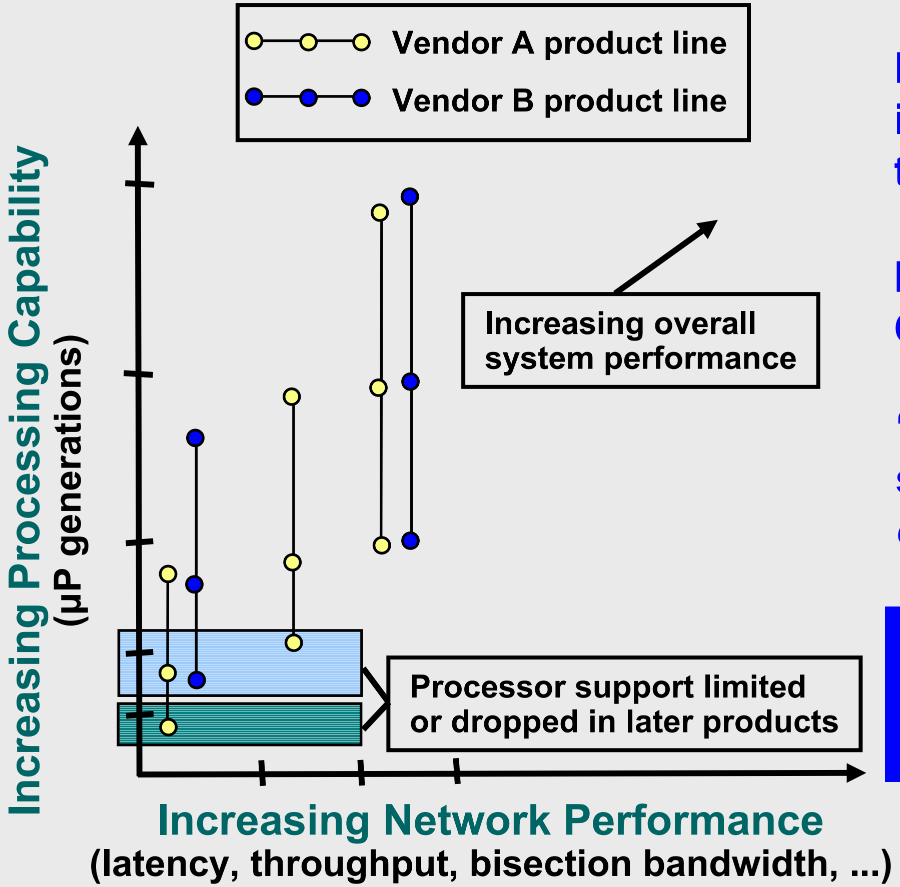
Example: Data movement with block to cyclic redistribution



This example shows a one-dimensional data set stored in block fashion mapped on three nodes being re-distributed in cyclic fashion over two nodes.

- Application programmer uses DRI to move data
- DRI hides complex data movement from programmer

Model-Year Portability


○—○—○ Vendor A product line
●—●—● Vendor B product line
Increasing overall system performance
Processor support limited or dropped in later products
Increasing Processing Capability
(µP generations)
Increasing Network Performance
(latency, throughput, bisection bandwidth, ...)

Portable software leverages inevitable advances in COTS HPC technology

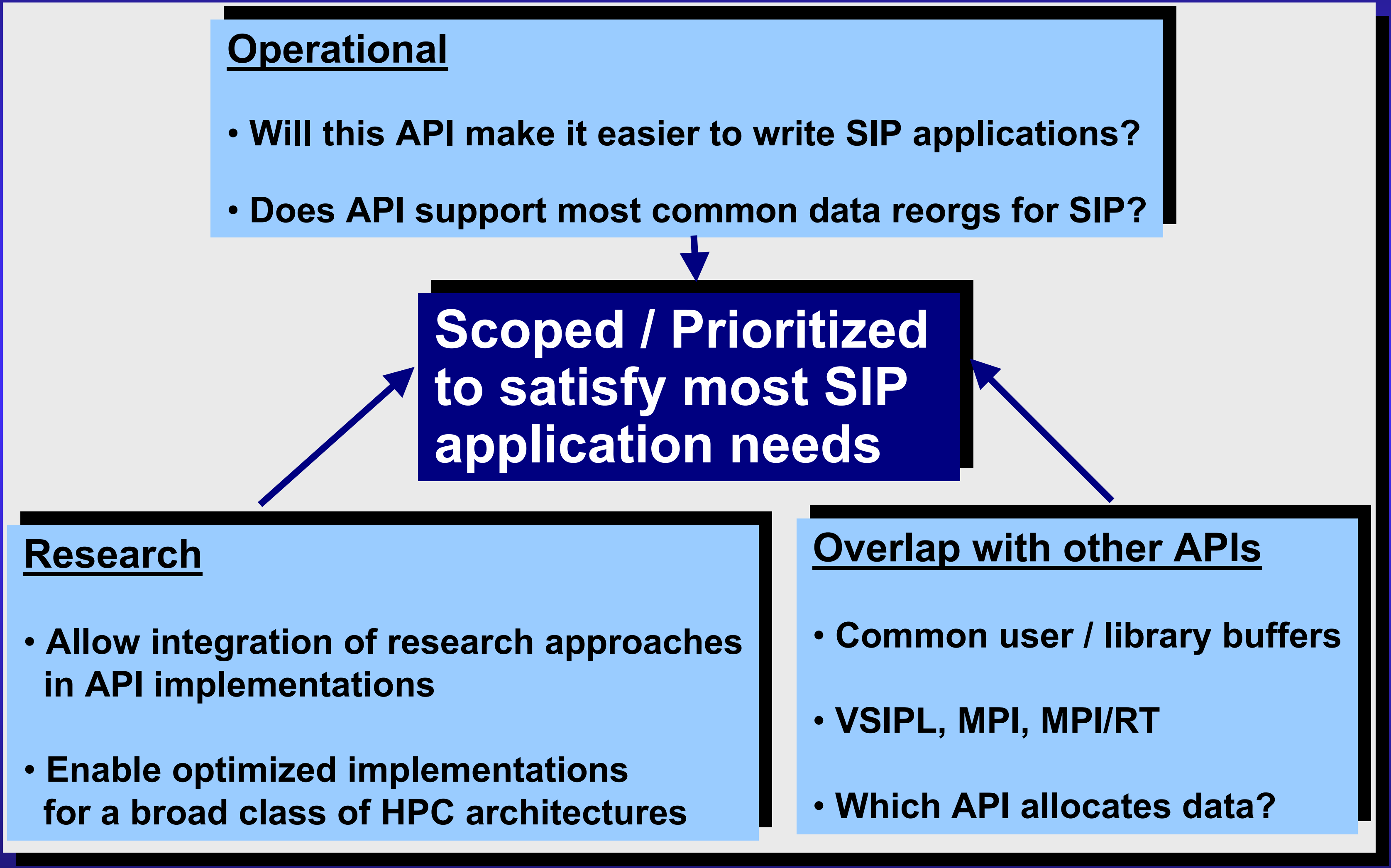
Defense system lifetimes: long
COTS HPC system lifetimes: short

"Point" solutions specific to a single vendor are long-term *cost ineffective*

Portable software with high performance is a powerful tool and is the ultimate goal

Challenges to Achieving Consensus In A Committee Context

Three Areas of Concern



Operational

- Will this API make it easier to write SIP applications?
- Does API support most common data reorgs for SIP?

Scoped / Prioritized to satisfy most SIP application needs

Research

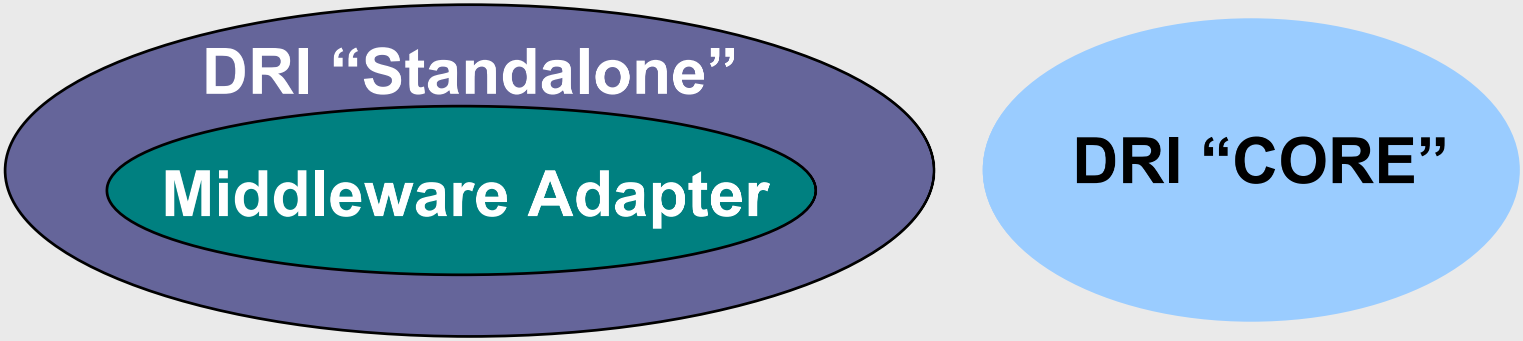
- Allow integration of research approaches in API implementations
- Enable optimized implementations for a broad class of HPC architectures

Overlap with other APIs

- Common user / library buffers
- VSIPL, MPI, MPI/RT
- Which API allocates data?

Data Reorg Committee Status

Data Reorg
Objects and Implementation Approaches



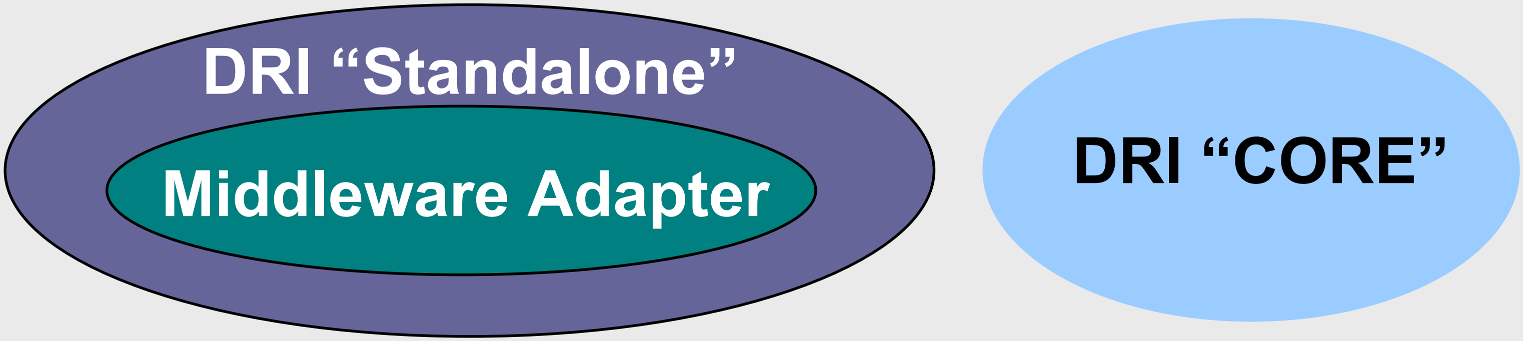
CORE

- Uniquely part of Data Reorganization API

- Must be provided in all Data Reorg implementations

- Objects:
  - `DRI_Global_Data`
  - `DRI_Partition`
  - `DRI_Distribution`
  - `DRI_Layout`
  - `DRI_View`
  - `DRI_Overlap`

Data Reorg
Objects and Implementation Approaches



Standalone

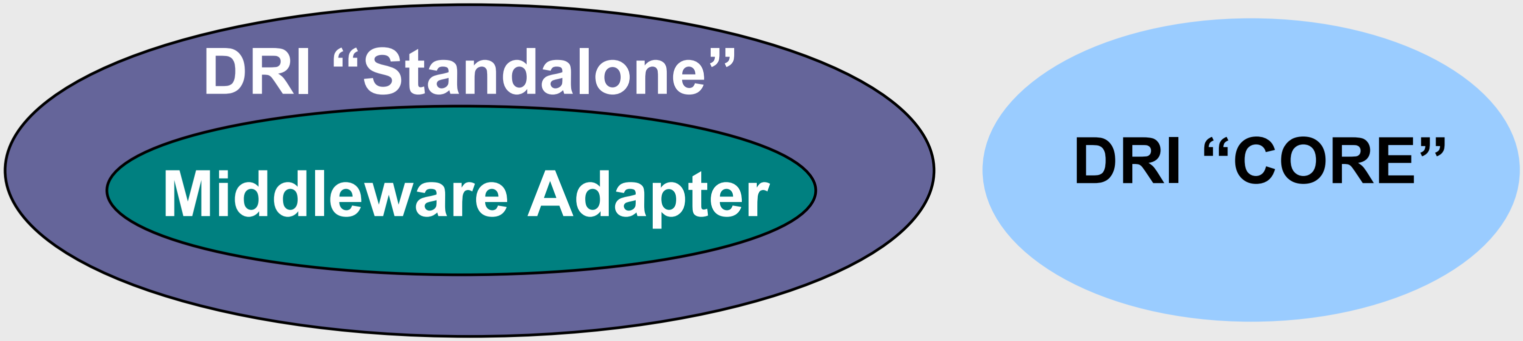
- Functionality overlaps with other middleware

- Full implementation (without Middleware Adapter) gives a "pure" data reorg programming environment

- Objects:

Datatypes	DRI_Dataspec
Process Sets	DRI_Group
User and Library Memory	DRI_Bufferset DRI_Buffer_Id
Data Transmission Constructs	DRI_Channel

Data Reorg
Objects and Implementation Approaches



Middleware Adapter

- Defines a hybrid interface that leverages supporting middleware
  - MPI
  - MPI/RT
  - Mercury PAS
  - Sky SCL

- Objects:
  - Selected from "Standalone", depending on supporting middleware

Data Re-org Forum Plan

- Two more official meetings
- Several informal “working” meetings
  - Resolve issues with buffers and buffersets
  - Resolve issues with memory layouts and distributions
- Near-Term activities:
  - Establish CORE and Standalone Interfaces
  - Define MPI Middleware Adapter for Data Reorg
  - Final document detailing ideas and lessons learned

In the long term, the forum feels that a larger effort in this area would have substantial benefits for the high-performance embedded computing community